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(54) **NETWORK FLOW SWITCHING AND FLOW DATA EXPORT**

(75) Inventors: **Darren R. Kerr**, Union City, CA (US); **Barry L. Bruins**, Los Altos, CA (US)

(73) Assignee: **Cisco Technology, Inc.**, San Jose, CA (US)

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(51) **Int. Cl.**[7] **H04L 12/56**
(52) **U.S. Cl.** **370/392**; 370/395.32
(58) **Field of Search** 370/229, 389, 370/392, 395, 401, 395.1, 395.3, 395.31, 395.32, 473; 709/238

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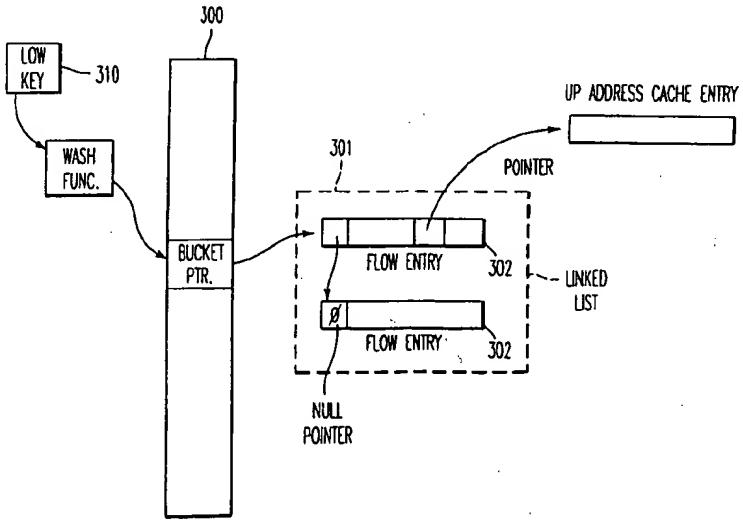
Primary Examiner—Min Jung
(74) *Attorney, Agent, or Firm*—Baker Botts L.L.P.

(57) **ABSTRACT**

The invention provides a method and system for switching in networks responsive to message flow patterns. A message "flow" is defined to comprise a set of packets to be transmitted between a particular source and a particular destination. When routers in a network identify a new message flow, they determine the proper processing for packets in that message flow and cache that information for that message flow. Thereafter, when routers in a network identify a packet which is part of that message flow, they process that packet according to the proper processing for packets in that message flow. The proper processing may include a determination of a destination port for routing those packets and a determination of whether access control permits routing those packets to their indicated destination.

33 Claims, 5 Drawing Sheets



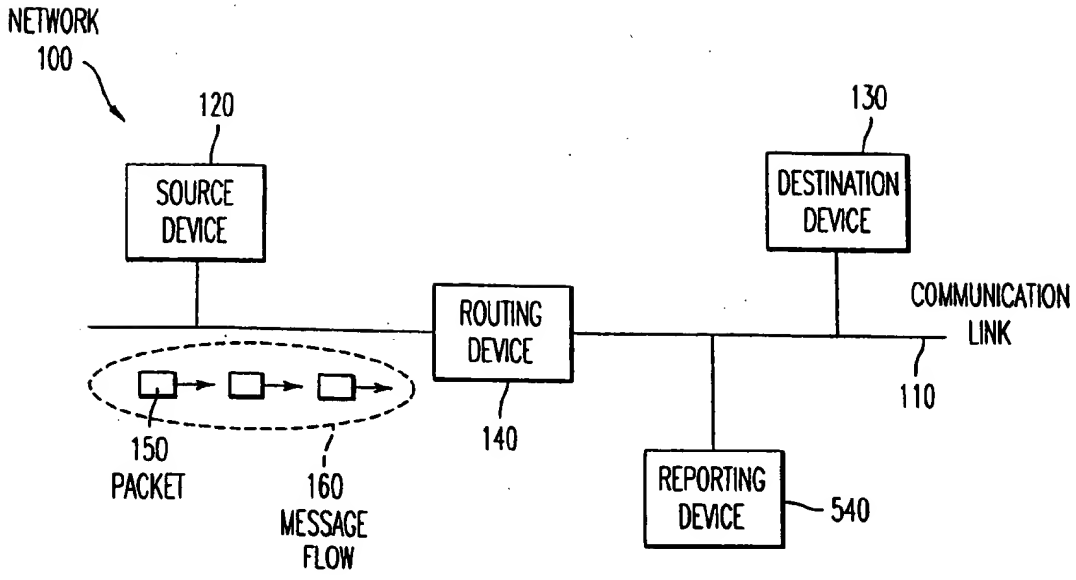

NETWORK
100
120
SOURCE DEVICE
130
DESTINATION DEVICE
ROUTING DEVICE
140
COMMUNICATION LINK
110
150
PACKET
160
MESSAGE FLOW
REPORTING DEVICE
540

FIG. 1

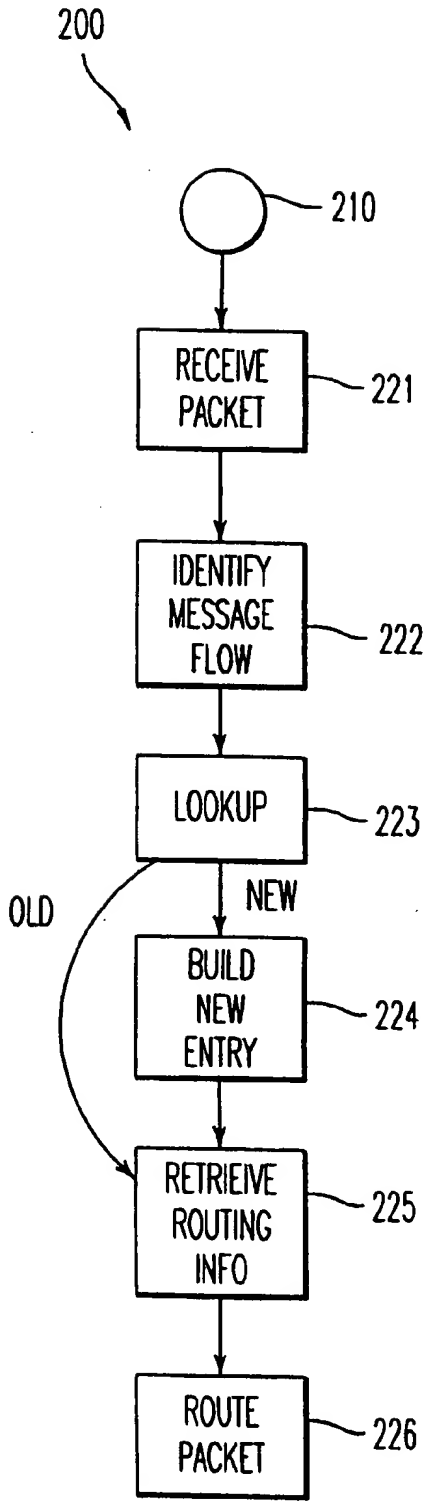

200
210
RECEIVE PACKET
221
IDENTIFY MESSAGE FLOW
222
LOOKUP
223
OLD
NEW
BUILD NEW ENTRY
224
RETRIEIVE ROUTING INFO
225
ROUTE PACKET
226

FIG. 2A

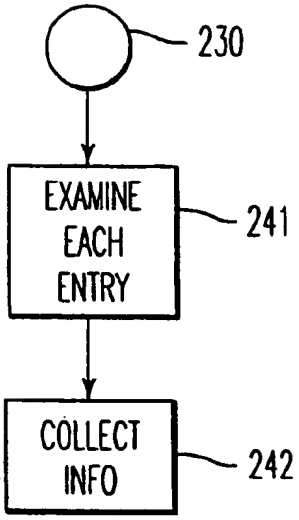

230
EXAMINE EACH ENTRY
241
COLLECT INFO
242

FIG. 2B

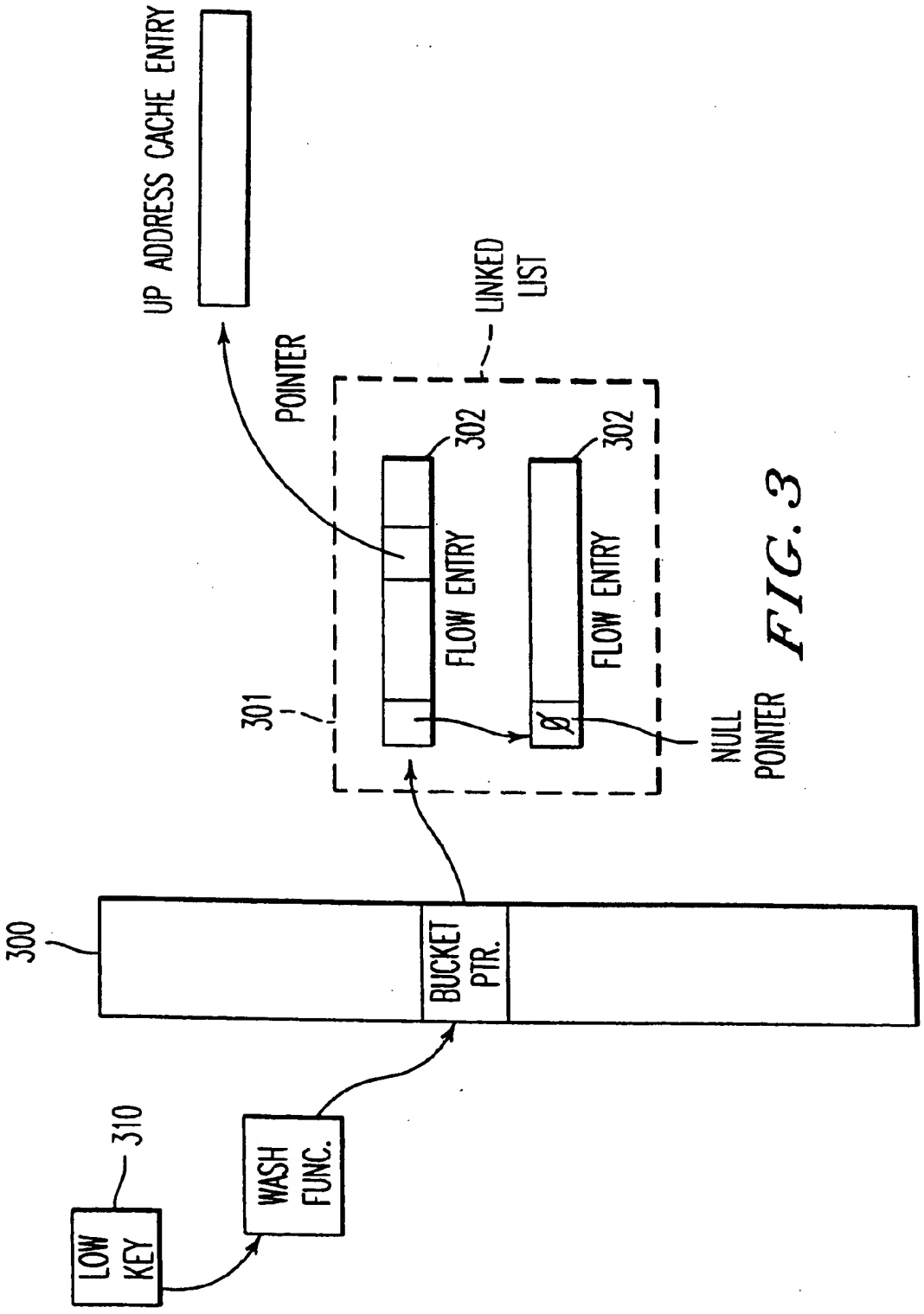

UP ADDRESS CACHE ENTRY
POINTER
LINKED LIST
302
302
FLOW ENTRY
FLOW ENTRY
301
NULL POINTER
300
BUCKET PTR.
310
WASH FUNC.
LOW KEY

FIG. 3

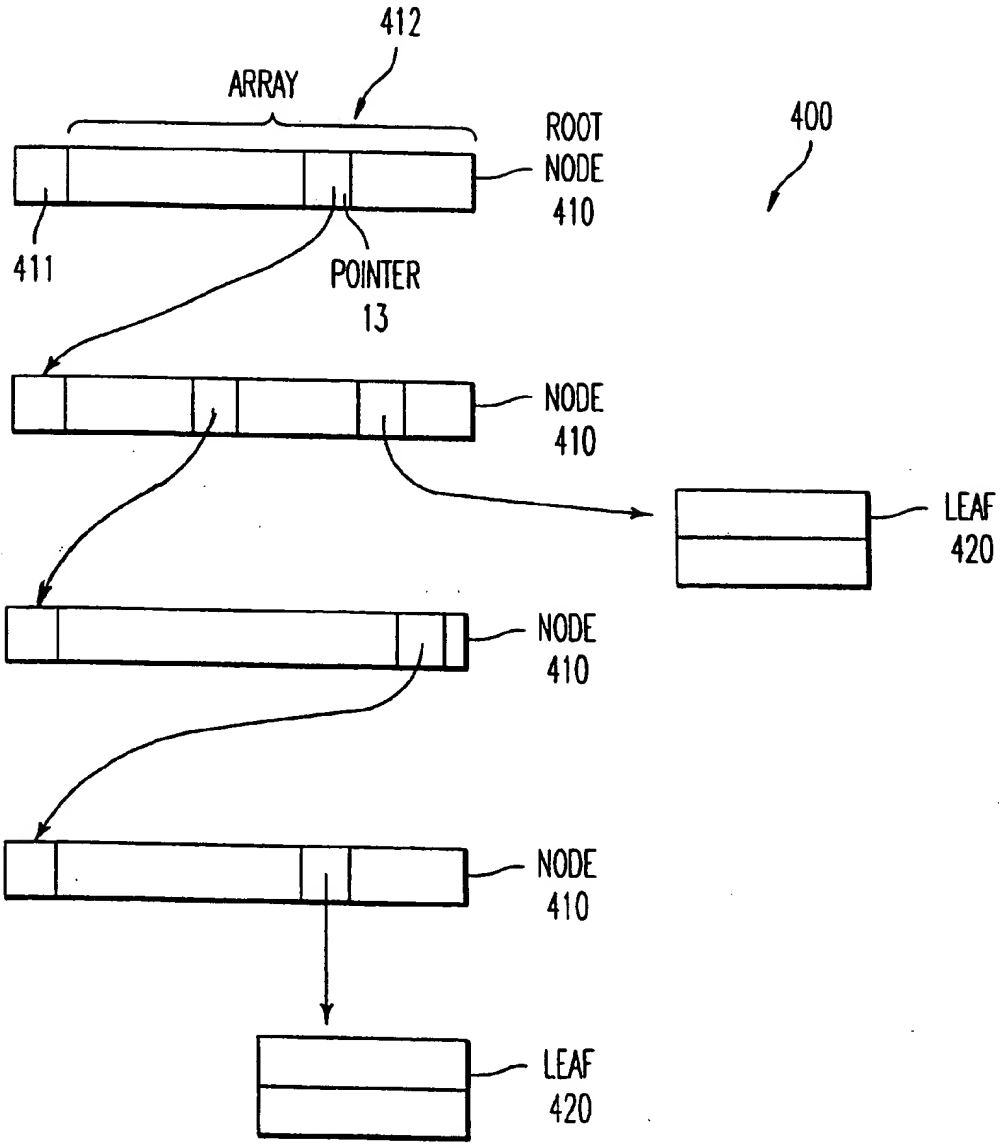

412
ARRAY
ROOT
NODE
410
400
411
POINTER
13
NODE
410
LEAF
420
NODE
410
NODE
410
LEAF
420

FIG. 4

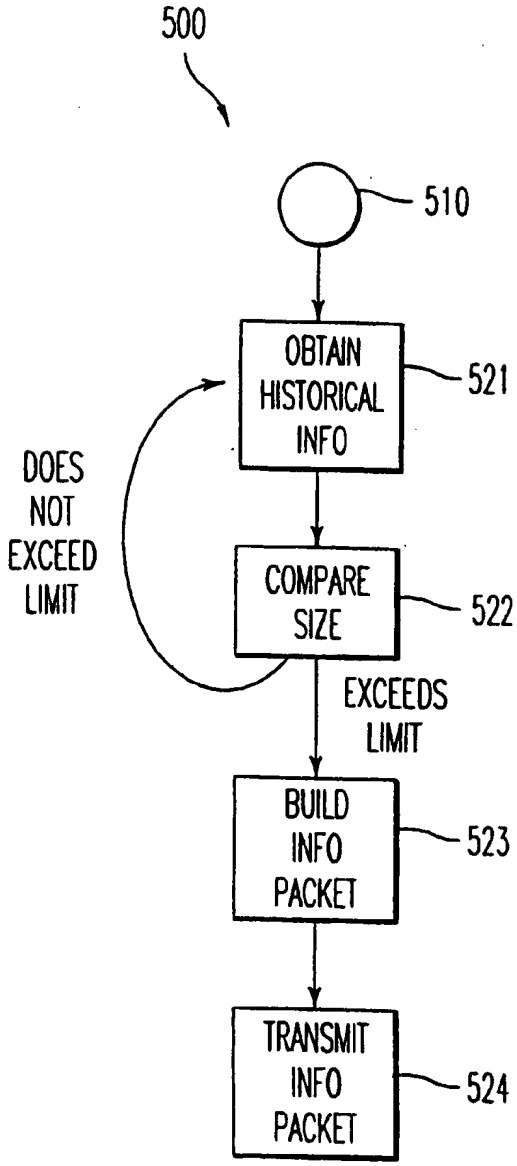

500
510
OBTAIN HISTORICAL INFO
521
DOES NOT EXCEED LIMIT
COMPARE SIZE
522
EXCEEDS LIMIT
BUILD INFO PACKET
523
TRANSMIT INFO PACKET
524

FIG. 5A

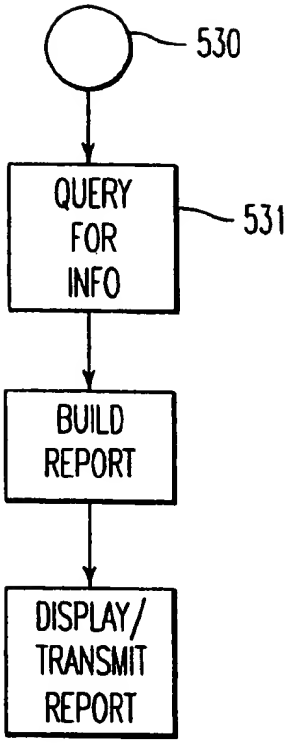

530
QUERY FOR INFO
531
BUILD REPORT
DISPLAY/ TRANSMIT REPORT

FIG. 5B

NETWORK FLOW SWITCHING AND FLOW DATA EXPORT

This is a continuation of application Ser. No. 08/655,429, filed May 28, 1996.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to network switching and data export responsive to message flow patterns.

2. Description of Related Art

In computer networks, it commonly occurs that message traffic between a particular source and a particular destination will continue for a time with unchanged routing or switching parameters. For example, when using the file-transfer protocol "FTP" there is substantial message traffic between the file's source location and the file's destination location, comprising the transfer of many packets which have similar headers, differing in the actual data which is transmitted. During the time when message traffic continues, routing and switching devices receiving packets comprising that message traffic must examine those packets and determine the processing thereof.

One problem which has arisen in the art is that processing demands on routing and switching devices continue to grow with increased network demand. It continues to be advantageous to provide techniques for processing packets more quickly. This problem has been exacerbated by addition of more complex forms of processing, such as the use of access control lists.

It would therefore be advantageous to provide techniques in which the amount of processing required for any individual packet could be reduced. With inventive techniques described herein, information about message flow patterns is used to identify packets for which processing has already been determined, and therefore to process those packets without having to re-determine the same processing. The amount of processing required for any individual packet is therefore reduced.

Information about message flow patterns would also be valuable for providing information about use of the network, and could be used for a variety of purposes by network administrators, routing devices, service providers, and users.

Accordingly, it would be advantageous to provide a technique for network switching and data export responsive to message flow patterns.

SUMMARY OF THE INVENTION

The invention provides a method and system for switching in networks responsive to message flow patterns. A message "flow" is defined to comprise a set of packets to be transmitted between a particular source and a particular destination. When routers in a network identify a new message flow, they determine the proper processing for packets in that messageflow and cache that information for that message flow. Thereafter, when routers in a network identify a packet which is part of that message flow, they process that packet according to the proper processing for packets in that message flow. The proper processing may induce a determination of a destination port for routing those packets and a determination of whether access control permits routing those packets to their indicated destination.

In another aspect of the invention, information about message flow patterns is collected, responsive to identified message flows and their packets. The collected information is reported to devices on the network. The collected information is used for a variety of purposes, including: to diagnose actual or potential network problems, to determine patterns of usage by date and time or by location, to determine which services and which users use a relatively larger or smaller amount of network resources, to determine which services are accessed by particular users, to determine which users access particular services, or to determine usage which falls within selected parameters (such as: access during particular dates or times, access to prohibited services, excessive access to particular services, excessive use of network resources, or lack of proper access).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a network in which routing responsive to message flow patterns is performed.

FIG. **2** shows a method for routing in networks responsive to message flow patterns.

FIG. **3** shows data structures for use with a method for routing in networks responsive to message flow patterns.

FIG. **4** shows an IP address cache for use with a method for routing in networks responsive to message flow patterns.

FIG. **5** shows a method for collecting and reporting information about message flow patterns.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. However, those skilled in the art would recognize, after perusal of this application, that embodiments of the invention may be implemented using a set of general purpose computers operating under program control, and that modification of a set of general purpose computers to implement the process steps and data structures described herein would not require undue invention.

Message Flows

FIG. **1** shows a network in which routing responsive to message flow patterns is performed.

A network **100** includes at least one communication link **110**, at least one source device **120**, at least one destination device **130**, and at least one routing device **140**. The routing device **140** is disposed for receiving a set of packets **150** from the source device **120** and routing them to the destination device **130**.

The communication link **110** may comprise any form of physical media layer, such as ethernet, FDDI, or HDLC serial link.

The routing device **140** comprises a routing processor for performing the process steps described herein, and may include specific hardware constructed or programmed performing the process steps described herein, a general purpose processor operating under program control, or some combination thereof.

A message flow **160** consists of a unidirectional stream. of packets **150** to be transmitted between particular pairs of transport service access points (thus, network-layer addresses and port numbers). In a broad sense, a message flow **160** thus refers to a communication "circuit" between communication end-points. In a preferred embodiment, a message flow **160** is defined by a network-layer address for a particular source device **120**, a particular port number at the source device **120**, a network-layer address for a par-

ticular destination device **130**, a particular port number at the destination device **130**, and a particular transmission protocol type. For example, the transmission protocol type may identify a known transmission protocol, such as UDP, TCP, ICMP, or IGMP (internet group management protocol).

In a preferred embodiment for use with a network of networks (an "internet"), the particular source device **120** is identified by its IP (internet protocol) address. The particular port number at the source device **120** is identified by either a port number which is specific to a particular process, or by a standard port number for the particular transmission protocol type. For example, a standard port number for the TCP protocol type is **6** and a standard port number for the UDP protocol type is **17**. Other protocols which may have standard port numbers include the FTP protocol, the TELNET protocol, an internet telephone protocol, or an internet video protocol such as the "CUSeeMe" protocol; these protocols are known in the art of networking. Similarly, the particular destination device **130** is identified by its IP (internet protocol) address; the particular port number at the destination device **130** is identified by either a port number which is specific to a particular process, or a standard port number for the particular transmission protocol type.

It will be clear to those skilled in the art, after perusing this application, that the concept of a message flow is quite broad, and encompasses a wide variety of possible alternatives within the scope and spirit of the invention. For example, in alternative embodiments, a message flow may be bi-directional instead of unidirectional, a message flow may be identified at a different protocol layer level than that of transport service access points, or a message flow may be identified responsive to other factors. These other factors may include one or more of the following: information in packet headers, packet length, time of packet transmission, or routing conditions on the network (such as relative network congestion or administrative policies with regard to routing and transmission).

Network Flow Switching

FIG. **2** shows a method for routing in networks responsive to message flow patterns.

In broad overview, the method for routing in networks responsive to message flow patterns comprises two parts. In a first part, the routing device **140** builds and uses a flow cache (described in further detail with regard to FIG. **3**), in which routing information to be used for packets **150** in each particular message flow **160** is recorded and from which such routing information is retrieved for use. In a second part, the routing device **140** maintains the flow cache, such as by removing entries for message flows **160** which are no longer considered valid.

A method **200** for routing in networks responsive to message flow patterns is performed by the routing device **140**.

At a flow point **210**, the routing device **140** is disposed for building and using the flow cache.

At a step **221**, the routing device **140** receives a packet **150**.

At a step **222**, the routing device **140** identifies a message flow **160** for the packet **150**. In a preferred embodiment, the routing device **140** examines a header for the packet **150** and identifies the IP address for the source device **120**, the IP address for the destination device **130**, and the protocol type for the packet **150**. The routing device **140** determines the port number for the source device **120** and the port number for the destination device **130** responsive to the protocol type. Responsive to this set of information, the routing device **140** determines a flow key **310** (described with reference to FIG. **3**) for the message flow **160**.

At a step **223**, the routing device **140** performs a lookup in a flow cache for the identified message flow **160**. If the lookup is unsuccessful, the identified message flow **160** is a "new" message flow **160**, and the routing device **140** continues with the step **224**. If the lookup is successful, the identified message flow **160** is an "old" message flow **160**, and the routing device **140** continues with the step **225**.

In a preferred embodiment, the routing device **140** determines a hash table key responsive to the flow key **310**. This aspect of the step **223** is described in further detail with regard to FIG. **3**.

At a step **224**, the routing device **140** builds a new entry in the flow cache. The routing device **140** determines proper treatment of packets **150** in the message flow **160** and enters information regarding such proper treatment in a data structure pointed to by the new entry in the flow cache. In a preferred embodiment, the routing device **140** determines the proper treatment by performing a lookup in an IP address cache as shown in FIG. **4**.

In a preferred embodiment, the proper treatment of packets **150** in the message flow **160** includes treatment with regard to switching (thus, the routing device **140** determines an output port for switching packets **150** in the message flow **160**), with regard to access control (thus, the routing device **140** determines whether packets **150** in the message flow **160** meet the requirements of access control, as defined by access control lists in force at the routing device **140**), with regard to accounting (thus, the routing device **140** creates an accounting record for the message flow **160**), with regard to encryption (thus, the routing device **140** determines encryption treatment for packets **150** in the message flow **160**), and any special treatment for packets **150** in the message flow **160**.

In a preferred embodiment, the routing device **140** performs any special processing for new message flows **160** at this time. For example, in one preferred embodiment, the routing device **140** requires that the source device **120** or the destination device **130** must authenticate the message flow **160**. In that case, the routing device **140** transmits one or more packets **150** to the source device **120** or the destination device **130** to request information (such as a user identifier and a password) to authenticate the new message flow **160**, and receives one or more packets **150** comprising the authentication information. This technique could be useful for implementing security "firewalls" and other authentication systems.

Thereafter, the routing device **140** proceeds with the step **225**, using the information from the new entry in the flow cache, just as if the identified message flow **160** were an "old" message flow **160** and the lookup in a flow cache had been successful.

At a step **225**, the routing device **140** retrieves routing information from the entry in the flow cache for the identified message flow **160**.

In a preferred embodiment, the entry in the flow cache includes a pointer to a rewrite function for at least part of a header for the packet **150**. If this pointer is non-null, the routing device **140** invokes the rewrite function to alter the header for the packet **150**.

At a step **226**, the routing device **140** routes the packet **150** responsive to the routing information retrieved at the step **225**.

Thus, in a preferred embodiment, the routing device **140** does not separately determine, for each packet **150** in the

message flow **160**, the information stored in the entry in the flow cache. Rather, when routing a packet **150** in the message flow **160**, the routing device **140** reads the information from the entry in the flow cache and treats the packet **150** according to the information in the entry in the flow cache.

Thus, in a preferred embodiment, the routing device **140** routes the packet **150** to an output port, determines whether access is allowed for the packet **150**, determines encryption treatment for the packet **150**, and performs any special treatment for the packet **150**, all responsive to information in the entry in the flow cache.

In a preferred embodiment, the routing device **140** also enters accounting information in the entry in the flow cache for the packet **150**. When routing each packet **150** in the message flow **160**, the routing device **140** records the cumulative number of packets **150** and the cumulative number of bytes for the message flow **160**.

Because the routing device **140** processes each packet **150** in the message flow **160** responsive to the entry for the message flow **160** in the flow cache, the routing device **140** is able to implement administrative policies which are designated for each message flow **160** rather than for each packet **150**. For example, the routing device **140** is able to reserve specific amounts of bandwidth for particular message flows **160** and to queue packets **150** for transmission responsive to the bandwidth reserved for their particular message flows **160**.

Because the routing device **140** is able to associate each packet **150** with a particular message flow **160** and to associate each message flow **160** with particular network-layer source and destination addresses, the routing device **140** is able to associate network usage with particular work stations (and therefore with particular users) or with particular services available on the network. This can be used for accounting purposes, for enforcing administrative policies, or for providing usage information to interested parties.

For a first example, the routing device **140** is able to monitor and provide usage information regarding access using the HTTP protocol to world wide web pages at particular sites.

For a second example, the routing device **140** is able to monitor usage information regarding relative use of network resources, and to give priority to those message flows **160** which use relatively fewer network resources. This can occur when a first message flow **160** is using a relatively low-bandwidth transmission channel (such as a 28.8 kilobits per second modem transmission channel) and when a second message flow **160** is using a relatively high-bandwidth transmission channel (such as a T-1 transmission line).

At a flow point **230**, the routing device **140** is disposed for maintaining the flow cache.

At a step **241**, the routing device **140** examines each entry in the flow cache and compares a current time with a last time a packet **150** was routed using that particular entry. If the difference exceeds a first selected timeout, the message flow **160** represented by that entry is considered to have expired due to nonuse and thus to no longer be valid.

In a preferred embodiment, the routing device **140** also examines the entry in the flow cache and compares a current time with a first time a packet **150** was routed using that particular entry. If the difference exceeds a second selected timeout, the message flow **160** represented by that entry is considered to have expired due to age and thus to no longer be valid. The second selected timeout is preferably about one minute.

Expiring message flows **160** due to age artificially requires that a new message flow **160** must be created for the next packet **150** in the same communication session represented by the old message flow **160** which was expired. However, it is considered preferable to do so because it allows information to be collected and reported about message flows **160** without having to wait for those message flows **160** to expire from nonuse. For example, a multiple-broadcast communication session could reasonably last well beyond the time message flows **160** are expired for age, and if not so expired would mean that information about network usage would not account for significant network usage.

In a preferred embodiment, the routing device **140** also examines the entry in the flow cache and determines if the "next hop" information has changed. If so, the message flow **160** is expired due to changed conditions. Other changed conditions which might cause a message flow **160** to be expired include changes in access control lists or other changes which might affect the proper treatment of packets **150** in the message flow **160**. The routing device **140** also expires entries in the flow cache on a least-recently-used basis if the flow cache becomes too full.

If the message flow **160** is still valid, the routing device **140** continues with the next entry in the flow cache until all entries have been examined. If the message flow **160** is no longer valid, the routing device **140** continues with the step **242**.

At a step **242**, the routing device **140** collects historical information about the message flow **160** from the entry in the flow cache, and deletes the entry.

Flow Cache

FIG. **3** shows data structures for use with a method for routing in networks responsive to message flow patterns.

A flow cache **300** comprises a memory which associates flow keys **310** with information about message flows **160** identified by those flow keys **310**. The flow cache **300** includes a set of buckets **301**. Each bucket **301** includes a linked list of entries **302**. Each entry **302** includes information about a particular message flow **160**, including routing, access control, accounting, special treatment for packets **150** in that particular message flow **160**, and a pointer to information about treatment of packets **150** to the destination device **130** for that message flow **160**.

In a preferred embodiment, the flow cache **300** includes a relatively large number of buckets **301** (preferably about 16,384 buckets **301**), so as to minimize the number of entries **302** per bucket **301** and thus so as to minimize the number of memory accesses per entry **302**. Each bucket **301** comprises a four-byte pointer to a linked list of entries **302**. The linked list preferably includes only about one or two entries **302** at the most.

In a preferred embodiment, each entry **302** includes a set of routing information, a set of access control information, a set of special treatment information, and a set of accounting information, for packets **150** in the message flow **160**.

The routing information comprises the output port for routing packets **150** in the message flow **160**.

The access control information comprises whether access is permitted for packets **150** in the message flow **160**.

The accounting information comprises a time stamp for the first packet **150** in the message flow **160**, a time stamp for the most recent packet **150** in the message flow **160**, a cumulative count for the number of packets **150** in the message flow **160**, and a cumulative count for the number of bytes **150** in the message flow **160**.

IP Address Cache

FIG. **4** shows an IP address cache for use with a method for routing in networks responsive to message flow patterns.

An IP address cache **400** comprises a tree having a root node **410**, a plurality of inferior nodes **410**, and a plurality of leaf data structures **420**.

Each node **410** comprises a node/leaf indicator **411** and an array **412** of pointers **413**.

The node/leaf indicator **411** indicates whether the node **410** is a node **410** or a leaf data structure **420**; for nodes **410** it is set to a "node" value, while for leaf data structures **420** it is set to a "leaf" value.

The array **412** has room for exactly 256 pointers **413**; thus, the IP address cache **400** comprises an M-trie with a branching width of 256 at each level. M-tries are known in the art of tree structures. IP addresses comprise four bytes, each having eight bits and therefore 256 possible values. Thus, each possible IP address can be stored in the IP address cache **400** using at most four pointers **413**.

The inventors have discovered that IP addresses in actual use are unexpectedly clustered, so that the size of the IP address cache **400** is substantially less, by a factor of about five to a factor of about ten, than would be expected for a set of randomly generated four-byte IP addresses.

Each pointer **413** represents a subtree of the IP address cache **400** for its particular location in the array **412**. Thus, for the root node **410**, the pointer **413** at location **3** represents IP addresses having the form 3.xxx.xxx.xxx, where "xxx" represents any possible value from zero to 255. Similarly, in a sub-tree for IP addresses having the form 3.xxx.xxx.xxx, the pointer **413** at location **141** represents IP addresses having the form 3.141.xxx.xxx. Similarly, in a subtree for IP addresses having the form 3.141.xxx.xxx, the pointer **413** at location **59** represents IP addresses having the form 3.141.59.xxx. Similarly, in a sub-tree for IP addresses having the form 3.141.59.xxx, the pointer **413** at location **26** represents the IP address 3.141.59.26.

Each pointer **413** is either null, to indicate that there are no IP addresses for the indicated subtree, or points to an inferior node **410** or leaf data structure **420**. A least significant bit of each pointer **413** is reserved to indicate the type of the pointed-to structure; that is, whether the pointed-to structure is a node **410** or a leaf data structure **420**. In a preferred embodiment where pointers **413** must identify an address which is aligned on a four-byte boundary, the two least significant bits of each pointer **413** are unused for addressing, and reserving the least significant bit for this purpose does not reduce the scope of the pointer **413**.

Each leaf data structure comprises information about the IP address, stored in the IP address cache **400**. In a preferred embodiment this information includes the proper processing for packets **150** addressed to that IP address, such as a determination of a destination port for routing those packets and a determination of whether access control permits routing those packets to their indicated destination.

Flow Data Export

FIG. **5** shows a method for collecting and reporting information about message flow patterns.

A method **500** for collecting and reporting information about message flow patterns is performed by the routing device **140**.

At a flow point **510**, the routing device **140** is disposed for obtaining information about a message flow **160**. For example, in a preferred embodiment, as noted herein, the routing device **140** obtains historical information about a message flow **160** in the step **242**. In alternative embodiments, the routing device **140** may obtain information about message flows **160**, either in addition or instead, by occasional review of entries in the flow cache, or by directly monitoring packets **150** in message flows **160**.

It will be clear to those skilled in the art, after perusing this application, that the concept of reporting information about message flows is quite broad, and encompasses a wide variety of possible alternatives within the scope and spirit of the invention. For example, in alternative embodiments, information about message flows may include bi-directional traffic information instead of unidirectional traffic information, information about message flows may include information at a different protocol layer level other than that of transport service access points and other than that at which the message flow is itself defined, or information about message flows may include actual data transmitted as part of the message flow itself. These actual data may include one or more of the following: information in packet headers, information about files of file names transmitted during the message flow, or usage conditions of the message flow (such as whether the message flow involves steady or bursty transmission of data, or is relatively interactive or relatively unidirectional).

At a step **521**, the routing device **140** obtains historical information about a particular message flow **160**, and records that information in a flow data table.

At a step **522**, the routing device **140** determines a size of the flow data table, and compares that size with a selected size value. If the flow data table exceeds the selected size value, the routing device **140** continues with the step **523** to report flow data. If the flow data table does not exceed the selected size value, the routing device **140** returns to the step **521** to obtain historical information about a next particular message flow **160**.

At a step **523**, the routing device **140** builds an information packet, responsive to the information about message flows **160** which is recorded in the flow data table.

At a step **524**, the routing device **140** transmits the information packet to a selected destination device **130** on the network **100**. In a preferred embodiment, the selected destination device **130** is determined by an operating parameter of the routing device **140**. This operating parameter is set when the routing device **140** is initially configured, and may be altered by an operator of the routing device **140**.

In a preferred embodiment, the selected destination device **130** receives the information packet and builds (or updates) a database in the format for the RMON protocol. The RMON protocol is known in the art of network monitoring.

At a flow point **530**, a reporting device **540** on the network **100** is disposed for reporting using information about message flows **160**.

At a step **531**, the reporting device **540** queries the selected destination device **130** for information about message flows **160**. In a preferred embodiment, the reporting device **540** uses the RMON protocol to query the selected destination device **130** and to obtain information about message flows **160**.

At a step **532**, the reporting device **540** builds a report about a condition of the network **100**, responsive to information about message flows **160**.

At a step **533**, the reporting device **540** displays or transmits that report about the condition of the network **100** to interested parties.

In preferred embodiments, the report may comprise one or more of a wide variety of information, and interested parties may use that information for one or more of a wide variety of purposes. Some possible purposes are noted herein:

Interested parties may diagnose actual or potential network problems. For example, the report may comprise

information about packets **150** in particular message flows **160**, including a time stamp for a first packet **150** and a time stamp for a last packet **150** in the message flow **160**, a cumulative total number of bytes in the message flow **160**, a cumulative total number of packets **150** in the message flow **160**, or other information relevant to diagnosing actual or potential network problems.

Interested parties may determine patterns of usage of the network by date and time or by location. For example, the report may comprise information about which users or which services on the network are making relatively heavy use of resources. In a preferred embodiment, usage of the network **100** is displayed in a graphical form which shows use of the network **100** in a false-color map, so that network administrators and other interested parties may rapidly determine which services, which users, and which communication links are relatively loaded or relatively unloaded with demand.

Interested parties may determine which services are accessed by particular users, or which users access particular services. For example, the report may comprise information about which services are accessed by particular users at a particular device on the network **100**, or which users access a particular service at a particular device on the network **100**. This information may be used to market or otherwise enhance these services. In a preferred embodiment, users who access a particular world wide web page using the HTTP protocol are recorded, and information is sent to those users about changes to that web page and about further services available from the producers of that web page. Providers of the particular web page may also collect information about access to their web page in response to date and time of access, and location of accessing user.

Information about patterns of usage of the network, or about which services are accessed by particular users, or which users access particular services, may be used to implement accounting or billing for resources, or to set limits for resource usage, such as by particular users, by particular service providers, or by particular protocol types (and therefore by particular types of services).

Interested parties may determine usage which falls within (or without) selected parameters. These selected parameters may involve access during particular dates or times, such as for example access to particular services during or outside normal working hours. For example, it may be desirable to record those accesses to a company database which occur outside normal working hours.

These selected parameters may involve access to prohibited services, excessive access to particular services, or excessive use of network resources, such as for example access to particular servers using the HTTP protocol or the FTP protocol which fall within (or without) a particular administrative policy. For example, it may be desirable to record accesses to repositories of games or other recreational material, particularly those accesses which occur within normal working hours.

These selected parameters may involve or lack of proper access, such as for example access control list failures or unauthorized attempts to access secure services. For example, it may be desirable to record unauthorized attempts to access secure services, particularly those attempts which form a pattern which might indicate a concerted attempt to gain unauthorized access.

In alternative embodiments, the routing device **140** could save the actual packets **150** for the message flow **160**, or some part thereof, for later examination. For example, a TELNET session (a message flow **160** comprising use of the TELNET protocol by a user and a host) could be recorded in its entirety, or some portion thereof, for later examination, e.g., to diagnose problems noted with the network or with the particular host.

In further alternative embodiments, the routing device **140** could save the actual packets **150** for selected message flows **160** which meet certain selected parameters, such as repeated un-authorized attempts to gain access.

In embodiments where actual packets **150** of the message flow **160** are saved, it would be desirable to perform a name translation (such as a reverse DNS lookup), because the IP addresses for the source device **120** and the destination device **130** are transitory. Thus, it would be preferable to determine the symbolic names for the source device **120** and the destination device **130** from the IP addresses, so that the recorded data would have greater meaning at a later time.

Alternative Embodiments

Although preferred embodiments are disclosed herein, many variations are possible which remain within the concept, scope, and spirit of the invention, and these variations would become clear to those skilled in the art after perusal of this application.

We claim:

1. A method for routing messages in a network, said method comprising:

(a) identifying a first packet of a first stream having at least one first routing treatment in common by searching a flow cache for a match with the first packet, and identifying the first packet when no match is found by the searching;

(b) recording said first routing treatment when no match is found by the search;

(c) identifying a second packet of said first stream of packets by searching the flow cache for a match with the second packet, and identifying the second packet when a match is found by the searching;

(d) routing said second packet responsive to said first routing treatment;

wherein said first stream of packets is associated with a selected source device and a selected destination device.

2. A method as in claim **1**, wherein said stream of packets is associated with a first selected port number at said source device and a second selected port number at said destination device.

3. A method as in claim **1**, wherein said first stream of packets comprises an ordered sequence, and said first packet has a selected position in said ordered sequence.

4. A method as in claim **1**, wherein said first stream of packets is transmitted between a selected pair of transport access points.

5. A method as in claim **1**, wherein said step of recording comprises building an entry in a flow cache.

6. A method as in claim **1**, further comprising (e) identifying a packet of a second stream of packets, said second stream of packets having at least one second routing treatment in common, said second routing treatment differing from said first routing treatment.

7. A method as in claim **1**, wherein said routing treatment comprises access control information for said first packet.

8. A method as in claim **1**, wherein said routing treatment comprises a destination output port for routing said first packet.

9. A method as in claim **1**, further comprising:

(e) recording information about said first stream of packets; and

(f) transmitting said information to at least one selected device on staid network.

10. A method as in claim 9, wherein said information includes:

a transmission time for an initial packet in said first stream of packets;

a transmission time for a most recent one packet in said first stream of packets;

a cumulative count of bytes in said first stream of packets; or

a cumulative count of said packets in said first stream of packets.

11. A method as in claim 9, further comprising:

(e) receiving said information at said selected device on said network;

(f) recording said information in a database at said selected device; and

(g) making said information available to a second device on said network.

12. A method as in claim 9, wherein said information includes:

a transmission time for an initial packet in said first stream of packets.

13. A method as in claim 9, wherein said information includes:

a transmission time for a most recent packet in said first stream of packets.

14. A method as in claim 9, wherein said information includes:

a cumulative count of bytes in said first stream of packets.

15. A method as in claim 9, wherein said information includes:

a cumulative count of said packets in said first stream of packets.

16. A system for routing packets in a network, said system comprising:

(a) means for receiving a plurality of packets, said plurality of packets comprising a plurality of message flows, each message flow comprising a stream of packets associated with a selected source device and a selected destination device, each said packet being associated with one selected message flow, and each said message flow having at least one routing treatment in common;

(b) means for associating packets with a first one of said message flows;

(c) means for searching a flow cache for a match with said first one message flow;

(d) means for inputting an entry into the flow cache associated with said first one message flow when no match is found by the searching; and

(e) means for routing packets responsive to entries in said flow cache.

17. A system as in claim 16, wherein said entry comprises access control information.

18. A system as in claim 17, wherein said entry comprises a destination output port for routing packets.

19. A system as in claim 16, further comprising (e) means for transmitting information responsive at least one said entry to at least one selected device on said network.

20. A system as in claim 19, wherein said information includes:

a transmission time for a first packet in each message flow;

a transmission time for a most recent packet in each message flow;

a cumulative count of bytes in each message flow;

a cumulative count of a number of packets in each message flow.

21. A system as in claim 19, wherein said information includes:

a transmission time for a first packet in each message flow.

22. A system as in claim 19, wherein said information includes:

a transmission time for a most recent packet in each message flow.

23. A system as in claim 19, wherein said information includes:

a cumulative count of bytes in each message flow.

24. A system as in claim 19, wherein said information includes:

a cumulative count of a number of packets in each message flow.

25. A system for routing packets in a network, said system comprising:

(a) a routing device to receive a plurality of packets, said plurality of packets comprising a plurality of message flows, each message flow comprising a stream of packets associated with a selected source device and a selected destination device, each said packet being associated with one selected message flow, and each said message flow having at least one routing treatment in common, wherein said routing device includes:

(a1) a routing processor to associate packets with a first one of said message flows;

(a2) a flow cache having an entry associated with said first one message flow, wherein said routing processor searches said flow cache for a match with said first one message flow and inputs the entry associated with said first one message flow when no match is found by the searching; and

(a3) the routing processor routing packets responsive to entries in said flow cache.

26. A system as in claim 25, wherein said entry comprises access control information.

27. A system as in claim 26, wherein said entry comprises a destination output port for routing packets.

28. A system as in claim 27, wherein said routing processor further transmits information responsive at least one said entry to at least one selected device on said network.

29. A system as in claim 28, wherein said information includes:

a transmission time for a first packet in each message flow;

a transmission time for a most recent packet in each message flow;

a cumulative count of bytes in each message flow; or

a cumulative count of a number of packets in each message flow.

30. A system as in claim 29, wherein said information includes:

a transmission line for a first packet in each message flow.

31. A system as in claim 29, wherein said information includes:

a transmission time for a most recent packet in each message flow.

32. A system as in claim 29, wherein said information includes:

a cumulative count of bytes in each message flow.

33. A system as in claim 29, wherein said information includes:

a cumulative count of a number of packets in each message flow.

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